OIPE JC112
SEP 30 2004
PATENT & TRADEMARK OFFICE

RECEIVED
OCT 06 2004
Technology Center 2600

AMENDMENTS TO THE CLAIMS

1. (Currently Amended) A comparative measuring device, comprising:

a camera adapted to generate a first set of images of an item being measured before an event, and generate a second set of images of the item after the event; and

a processor operatively associated with the camera and adapted to calculate ~~the~~ a first total volume of the item based on the first set of images and a second total volume of the item based on the second set of images, and output a first value for the first calculated total volume and a second value for the second calculated volume, wherein the processor is adapted to identify a first outline of the item using the first set of images and a second outline of the item using the second set of images and divide each outline into a plurality of two dimensional slices, each slice having a first dimension of a constant value and a second dimension of variable value.

2. (Cancelled).

3. (Currently amended) The measuring device of claim ~~2~~ 1, further including a rotatable platform upon which the item is placed and rotated through 360° of rotation, and wherein the camera is adapted to generate a plurality of digital images of the item across 360° of rotation.

4. (Original) The measuring device of claim 3, wherein the platform rotates in N steps around 360° of rotation, and wherein the camera generates N images of the item.

5. (Currently Amended) The measuring device of claim 4, wherein the processor calculates the first and second total volumes ~~volume~~ of the item using the equation:

~~volume = $\sum_{n=1}^{N} \sum_{m=1}^{M} 1/N \times h \times \prod \times (W_{mn}/2)$~~

volume = $\sum_{n=1}^{N} \sum_{m=1}^{M} 1/N \times h \times \prod \times (W_{mn}/2)^2$,

wherein h equals slice height, w equals slice width, N equals the total number of images, and M equals the total number of slices.

6. (Original) The measuring device of claim 3, wherein the rotatable platform is connected to a stepper motor.

7. (Original) The measuring device of claim 3, further including an isolation chamber, and wherein the rotatable platform and item are positioned within the isolation chamber.

8. (Original) The measuring device of claim 7, further including an opaque background within the isolation chamber.

9. (Currently Amended) The measuring device of claim 1, further including a display, the display adapted to communicate the first and second calculated total volumes ~~volume~~ to a user.

10. (Currently Amended) The measuring device of claim 9, wherein the ~~item volume is calculated before and after an~~ event results in a change in volume of the item, and wherein the volumes before and after the event are viewable on the display.

11. (Currently Amended) The measuring device of claim 10, wherein a change in volume between the before and after volumes is ~~are~~ displayed utilizing a difference ~~different~~ image with pixels j_{xy} with the formula:

$$j_{xy} = \frac{I_{hm}}{I_m}(k_{xy} - i_{xy}) + I_{hm},$$

where I_m represents maximum pixel intensity, I_{hm} represents half of the maximum pixel intensity, i_{xy} represents pixel intensities before the change in volume, and k_{xy} represents pixel intensities after the change in volume.

12. (Currently Amended) The measuring device of claim 10, wherein the total volumes before and after the event are displayed as three dimensional representations of the item.

13. (Currently Amended) The measuring device of claim 12, wherein the total volumes before and after are displayed repeatedly in alternating fashion.

14. (Original) The measuring device of claim 10, wherein the event is shrinkage of the item.

15. (Original) The measuring device of claim 14, wherein the item is a dental material, and the shrinkage occurs as a result of polymerization due to exposure of the item to light.

16. (Currently Amended) The measuring device of claim ~~7~~ 1, wherein the slices are horizontal, each slice has a height of one pixel and a width calculated by the processor by counting the number of pixels in each slice above a threshold level of intensity.

17. (Currently Amended) The measuring device of claim ~~2~~ 1, wherein the slices are horizontal, each slice has a height of one pixel, and a width calculated by identifying the left most and right most pixels in the slice above a threshold level of intensity, and using the following equation:

$$W_m = (x_{mR} - x_{mL}) + 1,$$

wherein W_m represents slice width, x_{mR} represents the right most pixel and x_{mL} represents the left most pixel.

18. (Currently Amended) A comparative volumetric measuring device, comprising:

a platform adapted to support an item to be measured and rotate the item in N increments across a 360° range of rotation;

a camera positioned proximate the platform and adapted to generate a first set of N images of the item and a second set of N images of the item subsequent to an event that may cause a change in volume of the item;

a processor operatively associated with the camera and adapted to identify outlines of the item in each image, the processor being further adapted to calculate ~~the~~ a first total volume of the item by calculating a first volume associated with each image and adding the volumes associated with each of the first set of N images, calculate a second total volume of the item by adding the volumes associated with each of the second set of N images, and output a value for the total volume; and

a display device operatively associated with the processor and adapted to display information associated with the calculated first and second total volumes ~~volume~~.

19. (Original) The volumetric measuring device of claim 18, wherein the camera is a charge-coupled device.

20. (Original) The volumetric measuring device of claim 18, wherein the platform is connected to a stepper motor.

21. (Original) The volumetric measuring device of claim 18, wherein the display device is a monitor adapted to display three-dimensional images representative of the item.

22. (Original) The volumetric measuring device of claim 18, further including an isolation chamber, the platform and camera being within the isolation chamber.

23. (Original) The volumetric measuring device of claim 22, further including an opaque background within the isolation chamber.

24. (Original) The volumetric measuring device of claim 23, further including at least one light source, the at least one light source being adapted to illuminate the item and not the background.

25. (Currently Amended) A method of calculating the volume of a sample, comprising the steps of:

(a) recording camera images of the sample from N angles, the N angles totaling 360°;

(b) digitizing the images on a pixel grid;

(c) identifying an outline of the sample by identifying the pixels within the grid above a predetermined threshold intensity for each image;

(d) dividing the image into a plurality of parallel slices;

(e) tabulating the height and width of each slice;

(f) calculating a volume associated with each slice; ~~and~~

(g) summing the calculated volumes associated with each slice for each of the N images to calculate a value for the total volume of the sample;

(h) subjecting the sample to an event that may change the sample volume; and

(i) repeating steps (a) through (g).

26. (Original) The method of claim 25, wherein each slice includes a plurality of portions and wherein the method further includes the step of calculating the volume of each slice portion before calculating the volume of each slice.

27. (Original) The method of claim 25, wherein the recording step is performed by placing the item on a platform, rotating the platform in N increments, and recording an image at each increment of rotation.

28. (Original) The method of claim 25, wherein the height tabulation step is performed by dividing the outline into a plurality of slices wherein each slice has a height of one pixel.

29. (Original) The method of claim 28, wherein the width calculation step is performed by counting the number of pixels within each slice above the threshold intensity.

30. (Original) The method of claim 29, wherein the calculating the volume step is performed using the equation:

$$v_s = 1/N \text{ x } h \text{ x } \prod \text{ x } (W_{mn}/2)^2 ,$$

wherein v represents the volume of the slice portion represented in the view, N represents the total number of images, h represents the height of the slice, and W_{mn} equals the width of the

slice.

31. (Original) The method of claim 30, wherein the summing step is performed using the equation:

$$v_t = \sum_{n=1}^{N} \sum_{m=1}^{M} 1/N \text{ x } h \text{ x } \prod \text{ x } (W_{mn}/2)^2,$$

wherein v_t represents total sample volume and M represents the number of slices in each image.

32. (Currently Amended) The method of claim 25, further including the ~~steps~~ step of ~~changing the sample volume, repeating the recording, digitizing, identifying, dividing, tabulating, calculating and summing steps, and~~ determining a percent change in sample volume before and after ~~the changing~~ step (h).

33. (Currently Amended) The method of claim ~~32~~ 25, wherein the sample is a dental material and ~~the changing~~ step (h) reduces the sample volume by curing the material upon exposure to light.

34. (Original) The method of claim 32, further including the step of displaying the change in volume on an operator interface device.

35. (Original) The method of claim 34, wherein the displaying step is performed by repeatedly displaying before and after images of the sample.

36. (Original) The method of claim 34, wherein the displaying step is performed by simultaneously displaying before and after images of the sample.

37. (Original) The method of claim 32, wherein the determining step is performed using the equation:

$$\Delta\%v_t = 100 \text{ x } (v_1 - v_2)/v_1,$$

wherein v_1 represents total sample volume before the changing step, and v_2 represents total sample volume after the changing step.

38. (Currently Amended) A method of calculating a total volume of a sample comprising the steps of:

(a) recording a camera image of the sample;

(b) tabulating a volume associated with the image by digitizing the camera image, dividing the digitized image into a series of slices, determining the width and height of each slice in terms of pixels, and calculating a slice volume based on the width and height before performing the tabulating step; ~~and~~

(c) calculating the total volume of the sample based on the tabulated volume associated with the image to determine a value for the total volume of the sample,

(d) subjecting the sample to an event that may change the total volume of the sample, and

(e) repeating steps (a) through (c).

39. (Currently Amended) The method of calculating a total volume of ~~a~~ the sample of claim 38, ~~further including the step of digitizing the camera image, dividing the digitized image into a series of slices, determining the width and height of each slice in terms of pixels, and calculating a slice volume based on the width and height before performing the tabulating step~~ wherein each pixel has an intensity, and an intensity slope is calculated for the sample.

40. (Currently Amended) The method of calculating a total volume of ~~a~~ the sample of

claim ~~39~~ 38, wherein each pixel has an intensity and wherein at least one of the height and width are determined by comparing each pixel intensity to a threshold level of intensity.

41. (New) The measuring device of claim 1, wherein each slice has a height of one pixel, each pixel has an intensity, and an intensity slope is calculated for the sample.

42. (New) A measuring device, comprising:

a camera adapted to generate images of an item being measured;

a processor operatively associated with the camera and adapted to calculate the total volume of the item based on the images, the processor adapted to identify an outline of the item and divide the outline into a plurality of two dimensional slices, each slice having a first dimension of a constant value and a second dimension of variable value; and

a rotatable platform upon which the item is placed and rotated through 360° of rotation, wherein the camera is adapted to generate a plurality of digital images of the item across 360° of rotation the platform rotates in N steps around 360° of rotation, and the camera generates N images of the item.

wherein the processor calculates the total volume of the item using the equation:

$$\text{volume} = \sum_{n=1}^{N} \sum_{m=1}^{M} 1/N \text{ x } h \text{ x } \prod \text{ x } (W_{mn}/2)^2,$$

wherein h equals slice height, w equals slice width, N equals the total number of images, and M equals the total number of slices.

43. (New) A measuring device, comprising:

a camera adapted to generate images of an item being measured;

a processor operatively associated with the camera and adapted to calculate the total volume of the item based on the images; and

a display, the display adapted to communicate the calculated volume to a user, wherein the item volume is calculated before and after an event, wherein the volumes before and after the event are viewable on the display, and wherein a change in volume between the before and after volumes is displayed utilizing a difference image with pixels j_{xy} with the formula:

$$j_{xy} = \frac{I_{hm}}{I_m}(k_{xy} - i_{xy}) + I_{hm},$$

where I_m represents maximum pixel intensity, I_{hm} represents half of the maximum pixel intensity, i_{xy} represents pixel intensities before the change in volume, and k_{xy} represents pixel intensities after the change in volume.

44. (New) A measuring device, comprising:

a camera adapted to generate images of an item being measured; and

a processor operatively associated with the camera and adapted to calculate the volume of the item based on the images, the processor adapted to identify an outline of the item and divide the outline into a plurality of two dimensional slices, each slice having a first dimension of a constant value and a second dimension of variable value, wherein the slices are horizontal, each slice has a height of one pixel, and a width calculated by identifying the left most and right most pixels in the slice above a threshold level of intensity, and using the following equation:

$$W_m = (x_{mR} - x_{mL}) + 1,$$

wherein W_m represents slice width, x_{mR} represents the right most pixel and x_{mL} represents the left most pixel.

45. (New) A method of calculating the total volume of a sample, comprising the steps of:

recording camera images of the sample from N angles, the N angles totaling 360°;

digitizing the images on a pixel grid;

identifying an outline of the sample by identifying the pixels within the grid above a predetermined threshold intensity for each image;

dividing the image into a plurality of parallel slices;

tabulating the height and width of each slice by dividing the outline into a plurality of slices wherein each slice has a height of one pixel and counting the number of pixels within each slice above the threshold intensity;

calculating a volume associated with each slice using the equation:

$$v_s = 1/N \text{ x } h \text{ x } \prod \text{ x } (W_{mn}/2)^2 ,$$

wherein v represents the volume of the slice portion represented in the view, N represents the total number of images, h represents the height of the slice, and W_{mn} equals the width of the slice; and

summing the calculated volumes associated with each slice for each of the N images.

46. (New) The method of claim 45, wherein the summing step is performed using the equation:

$$v_t = \sum_{n=1}^{N} \sum_{m=1}^{M} 1/N \text{ x } h \text{ x } \prod \text{ x } (W_{mn}/2)^2,$$

wherein v_t represents total sample volume and M represents the number of slices in each image.

47. (New) A method of calculating the total volume of a sample, comprising the steps of:

recording camera images of the sample from N angles, the N angles totaling 360°;

digitizing the images on a pixel grid;

identifying an outline of the sample by identifying the pixels within the grid above a predetermined threshold intensity for each image;

dividing the image into a plurality of parallel slices;

tabulating the height and width of each slice;

calculating a volume associated with each slice;

summing the calculated volumes associated with each slice for each of the N images;

changing the sample volume;

repeating the recording, digitizing, identifying, dividing, tabulating, calculating and summing steps; and

determining a percent change in sample volume before and after the changing step using the equation:

$$\Delta\%v_t = 100 \text{ x } (v_1 - v_2)/v_1,$$

wherein v_1 represents total sample volume before the changing step, and v_2 represents total sample volume after the changing step.